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16. Summary/Notes <i>The study of the MSS Landsat images of June 26 and September 24, 1973, of Lagoa dos Patos and adjacent coastal waters, located in the Southeastern part of Brazil, with relevant environmental data, gave an idea of the circulation tendencies in the interior of the lagoon and in the coastal waters nearby. The study was done utilizing a surface hydrodynamic model. The most important results are given as a cell circulation proposition with clockwise and counterclockwise vortices in the interior of the lagoon. A comparison of these results with the ones reached by other models such as Bonilla's, show important differences in the circulation patterns.</i>			
17. Remarks			

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CHAPTER I

INTRODUCTION

The coastal plain of Rio Grande do Sul (Brazil) is the result of a complex interaction of fluvial, marine and eolic processes which built the physiographic features of its 47,100 Km² (DELANEY, 1965) sandy deposits.

Its major axis, parallel to the coastal line (NE-SW), has a maximum length of 640 Km and an average width of 90 Km. These stratigraphic units constitute one of the most interesting geomorphic aspects of the Brazilian coastal Quaternary, with accumulation and erosional forms related to sea level changes during the last 500,000 years. Distinctive differences between the physiographic patterns allows the reconstitution of the main paleogeographic phases, through the sequential marine terraces, surrounding lakes and lagoons developed among the stratigraphic discontinuities.

The most recent evolution of coastal and lagoonal sedimentary features in that region has been due mainly to wind driven cellular currents whose tendencies can be seen in the orbital multispectral images from LANDSAT satellites by the changes in the optical properties of the waters (POLCYN and ROLIM, 1969).

CHAPTER II

DESCRIPTION OF THE METHOD

Following the methodology of STRANDBERG (w.d), STEINER, et al (1975), SMITH JR. (1968) for the multispectral image visual interpretation, the gray scale patterns were discriminated by a reflex step wedge (with constant 0,10 D) and selected automatically by a microdensitometer of Spectral Data Co. and the Image-100 system from General Electric Co.

The different gray shades, due to diverse optical properties caused by changes in the quality and concentration of sedimentary suspension particles, were used to indicate the hydrodynamical tendencies of the waters. The largest reflectance degrees were correlated with large turbidity levels which following RUHE (1975) and SUGUIO (1973), would be indicators of larger environment energy.

CHAPTER III

DESCRIPTION OF THE ORBITAL MODELS

The two models included in this paper show examples of applications of the proposed method, in an attempt to contribute to the improvement of the semi-empiric techniques used in hydrodynamics studies.

The two overpasses in the base orbit 192, during 1973 (with small cloud cover) recorded the complete surface image of the Lagoa dos Patos (10.360 km^2) and part of the coast (Fig. III.1), in three sequential MSS frames.

In June 26 and September 24, under different environmental conditions (Table III.1), i.e., weak to moderate SW winds and (Figs. III.2 and III.3) respectively for each one of the synoptic situations, we determined the circulation models showed in Figs. III.4 and III.5.

TABLE III.1

HYDROLOGICAL AND ATMOSPHERIC COMPONENTS CONSIDERED IN THE ORBITAL IMAGE INTERPRETATION

ENVIRONMENTAL COMPONENT	JUNE 26 FLOW IN m^3/sec	SEPTEMBER 24 FLOW IN m^3/sec
Guaíba estuary	3,360	5,050
Camaquã river	200	400
São Gonçalo channel	(-) 400	(-) 630
Rio Grande channel	(-) 5,000	15,000
Predominant wind	SW	NE

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Gray shades of higher density characterize the entrances of small lagoons and river basins with waters of low solid content. This fact was observed in the bottom of the Velhaco, Peixe and Camaquã rivers, and in Casamento lake also.

The high fluviometric levels in the Guaíba, corresponded to intense rain on the drainage basins of the rivers, Jacuĩ and Taquarĩ. The greatest concentrations of suspended solids, specially colored clays, due to the sesquiferrous oxides, is responsible for the high reflectance registered in the MSS band 5.

Due to the action of the wind, the material introduced in C1 by the Itapuã channel, is diffused to the south in an intermittent way and with the natural oscillations (Seiches) of the basin, which elevate the surface level of the Guaíba 0.20 m daily. The result of this environmental situation is marked by involvent arcs to the fanlike discharge of lighter tones.

In the coast, the accumulation of water to the SW of the last cell of the lagoon, produces an elevation of the water level in the channel.

In the first case (Fig. III.4) it is possible to see in the lagoon cells, clockwise vortices in the interior of the compartments C2, C3 and C4, while in C1 a counter clockwise vortex is being formed because of the interference of the São Simão sand ridge.

The distribution of the gray scale shades of the bordering waters of the lagoon, indicates greater turbidity due to the currents of greater intensity and turbulence. Such contrasts go along with the evolution of the vortices to the west side of the referred cells, which leads to admit that, in the Eastern border, a channel exists, where the increase of energy gives a great capacity of transportation to the waters.

Rising tides and extended duration of the SW winds in the

two periods before the images were taken, introduced, through the Rio Grande bar entrance, a significant amount of marine waters, which can be seen by the darker tones over the images.

Darker gray shades, observed towards the Rasa spit in MSS 5, show the penetration of saline mixed waters near the Feitoria sand bank. In this area, the zonal convergence lines are more precisely traced, due to the chemical processes acting on the fresh water suspended clay particles by the marine waters.

The weak coastal currents carrying suspended particulate matter in the SW direction, parallel to the coast, is the result of the NW-NE predominant winds observed in the preceding synoptic periods.

On September 24, the strong and continuous NW winds together with the high precipitation levels, produced the dynamic situation sketched in Figure III.5.

The pattern recognition in this model gave a complete picture of surface effects, where the circulation patterns became partially dissimilar from the cellular structure, and the accumulation of waters occurred to the SW part of the lagoonal basin ahead of the Rasa point causing a forced discharge of the lagoon waters into the coastal waters. Two counterclockwise vortices of large amplitudes are originated over the Carpinteiro sand bank and to the south of Cassino beach with a sudden elevation of the bottom, influencing the currents flowing parallel to the coast. The discharge of these lagoon waters over the continental shelf extends for more than 80 km offshore.

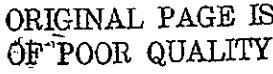


Fig. III.1 - Bathymetric map of Lagoa dos Patos .

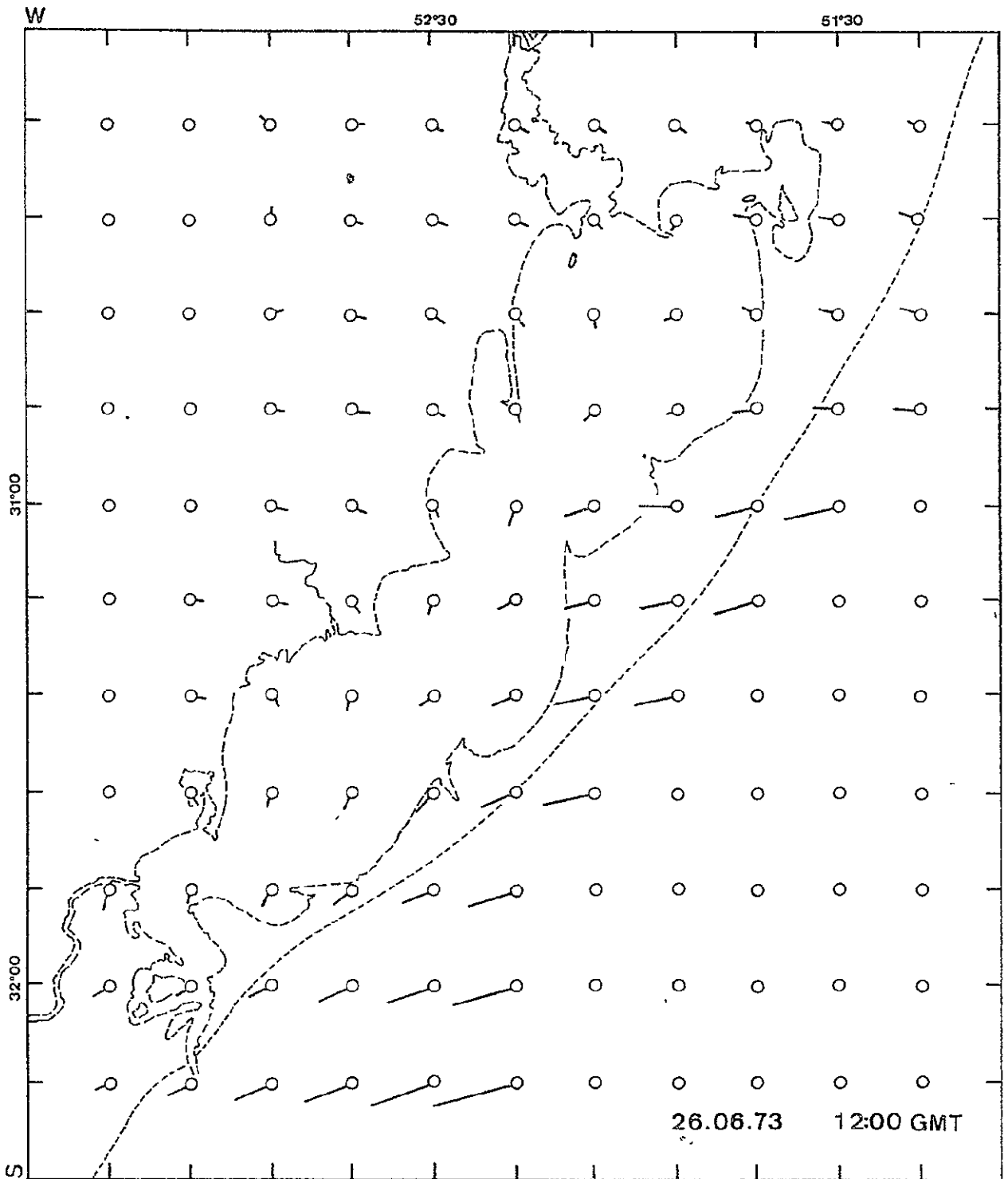


Fig. III.2' - Surface winds in the NW of Rio Grande do Sul in June 26, 1973 12:00 (GMT).

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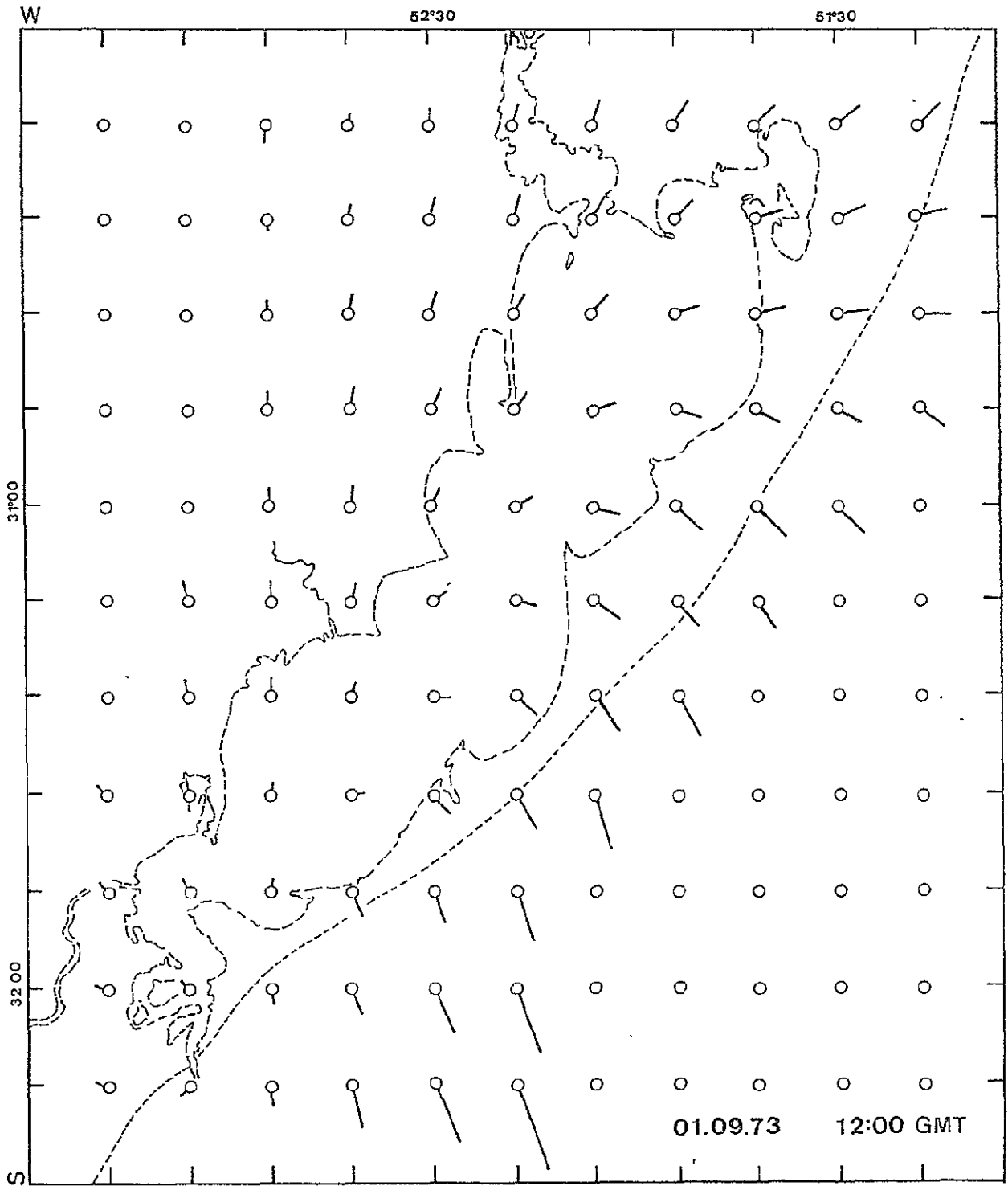


Fig. III.3 - Surface winds in the NW of Rio Grande do Sul in September 24, 1973 12:00 (GMT).

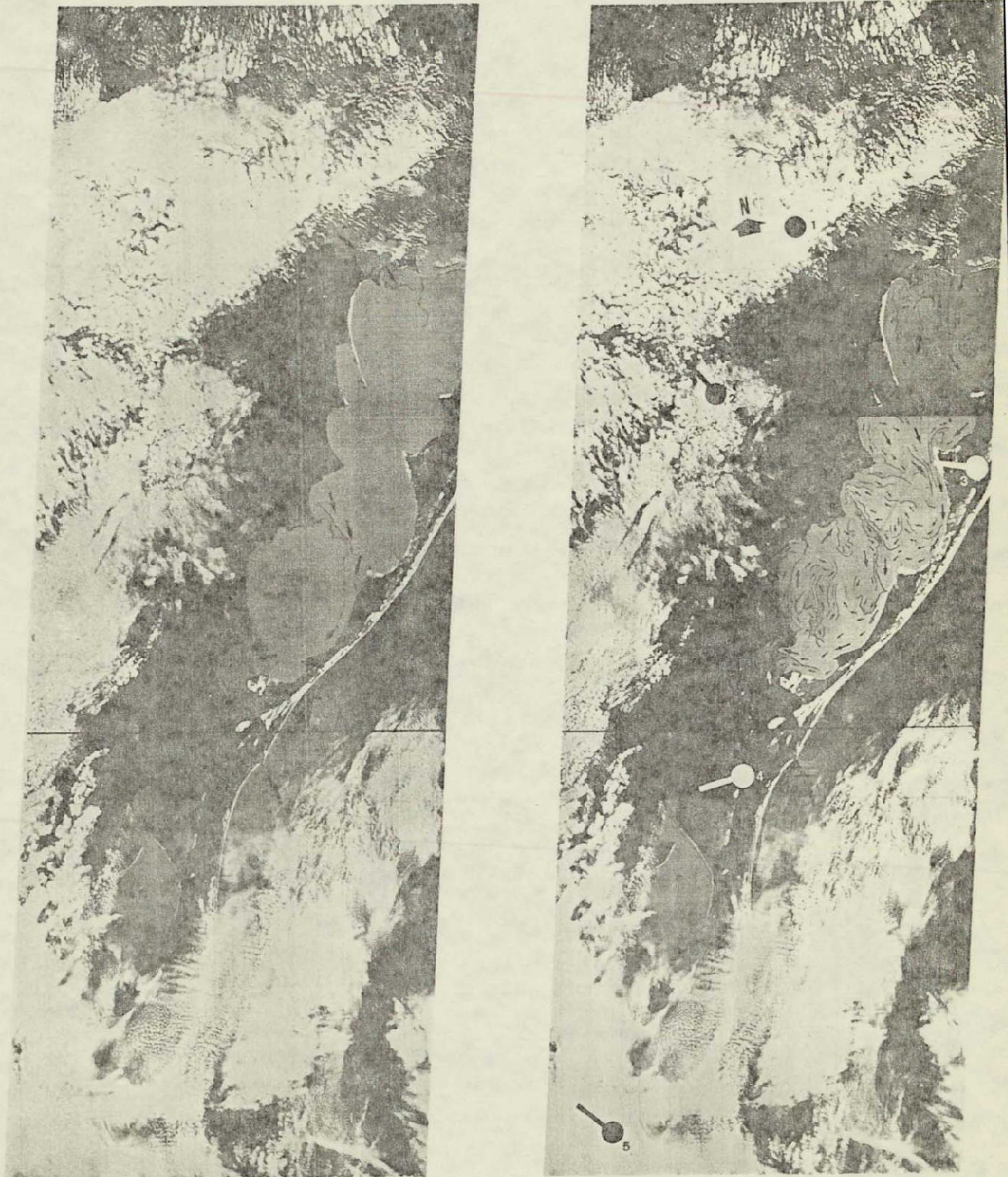


Fig. III.4 - Partial reproduction of the non controlled mosaics of the MSS-4 and MSS-5 images for the overflight of June 26, 1973 at 12:47 (GMT).

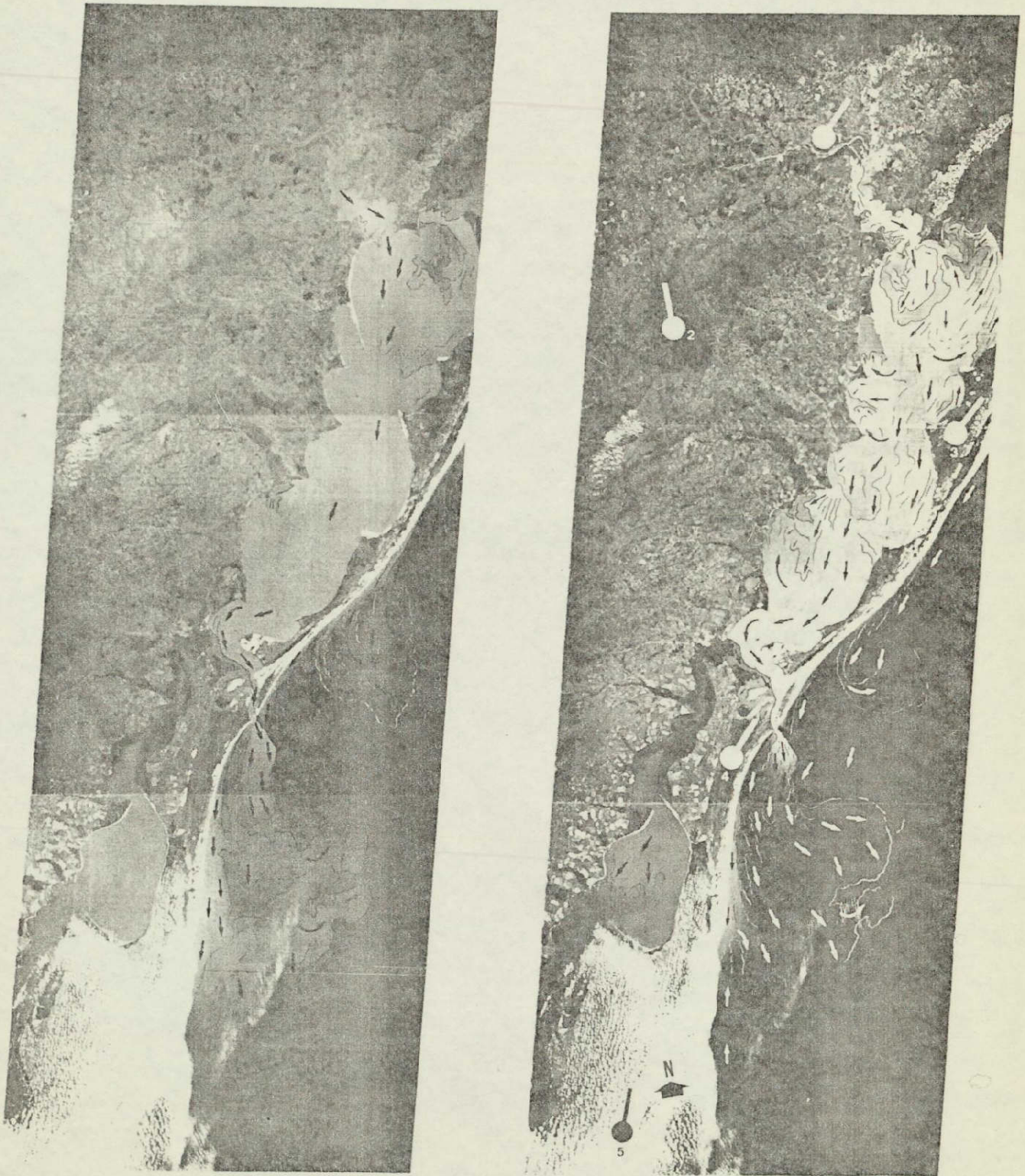


Fig. III.5 - Partial reproduction of the non controlled mosaics of the MSS-4 and MSS-5 for the overflight of June 09, 1973 at 12:47 (GMT).

CHAPTER IV

CONCLUSIONS

The results of the two cases studied are, by themselves, enough to justify the continuity of the research. But other methods of theoretical modeling will help. In fact, this method could act as an evaluation or control, provided the main physical variables are known.

If we compare the results obtained with the preliminar numerical models of BONILHA (1975), and the results of the trend surface analysis applied to the data of bottom sedimentary deposits (Fig.III.6), what has been told previously becomes clearer, since, the circulation tendencies presented by the first are by far different of the situations presented by the orbital models, coinciding only in some particular details. Besides, the model obtained from the granulometric parameters justifies the cell proposition, featuring the flow channel in the East border.

The systematic observation of orbital models could contribute effectively for a wider information, necessary to the increase in precision of the theoretical methods, which have a large content of empirism.

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